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FOREST INSECT INVESTIGATIONS

R.M.O.

WESTERN PINE BEETLE FLIGHT STUDY

SAN JOAQUIN PROJECT

1924

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June 9, 1927

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WESTERN PINE BEETLE FLIGHT STUDY

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INTRODUCTION

The need for more definite data on the flight habits of the western pine beetle (Dendroctonus brevicornis Lec.) has been recognized for a long time, but very little information has been collected, due principally to the difficulties encountered. Keen made a start on the problem by developing a stain which could be used for marking beetles, so that they could be identified after they had been liberated and subsequently recovered from trees which they had attacked after the flight period. Experiments based upon the use of this stain did not establish any conclusive evidence as to distance of flight, due to the failure to recover any of the marked beetles after they had been liberated.

The Bureau of Entomology has carried out a number of experiments to determine the distance from which beetles may be drawn to freshly-felled trap trees by locating such trees at some distance from any infested timber. In a trap-tree experiment carried out by Patterson near Ashland, Oregon, in 1920, beetles traveled for a distance of at least two miles to attack a trap tree located entirely outside of the timber belt. Several other records of a flight of approximately a mile have been secured by the use of traps.

However, the distance which beetles may fly to attack normal healthy trees may not correspond entirely to that where the especial attraction created by the trap is an important stimulating influence. So far the only data secured as to distance of flight under normal conditions of attack has been secured by general observations. Such studies are valuable and should be continued, as they have a direct bearing upon the effectiveness of control work. It is important to know how far an infestation spreads normally under different conditions and the rate at which an area, once cleaned by control work, becomes reinfested by beetles coming in from the outside.

An opportunity to obtain some data pertaining to distance of flight under normal conditions was presented during the course of the San Joaquin Project. This was an experimental insect control project carried out on the Sierra National Forest during the period from 1920 to 1924 inclusive, during the course of which several small areas termed units were worked with varying degrees of intensity. The Forked Meadow Unit was selected as the basis for a flight study which was carried out during the season of 1924.

CONDITIONS AFFECTING FORKED MEADOW UNIT

This unit includes 3200 acres in the west slope Sierra yellow pine type, with a stand of 36,894 M.B.M. of yellow pine and a small amount of Jeffrey and sugar pine. The form of the unit is that of an irregular circle, with a diameter of 2 miles from east to west and 3 miles from north to south. The area forms a fairly complete basin or topographic unit, the elevations ranging from 4000 to 5000 feet. The slopes are fairly gentle, and the topography is not considered sufficiently abrupt to act as a barrier. The pine type is continuous on all sides of the area, with no break to interfere with free movement of the beetles in or out of the unit.

Intensive control work was carried on against the western pine beetle over the entire unit during the seasons of 1922, 1923 and 1924. In 1923, the season preceding the experiment, the yellow pine loss was 67 trees, or 15 trees per section, with a total volume of 78,110 board feet. Forty-nine of these, with nearly 80 per cent of the volume, were treated.

Immediately adjoining this unit on the north and east was the Jackass Creek Unit, containing similar site and type conditions, on which no control work at all was done. This area was cruised and studied as a check on the results of the Forked Meadow experiment. For details of the control work see Miller's report, "Control of the Western Pine Beetle on the San Joaquin Project", dated December 20, 1924.

PLAN AND METHODS OF STUDY

The general plan of this experiment was to clean, so far as possible, all of the overwintering infested trees from the unit during the spring of 1924 and then follow the drift of the beetles back into the area. The beetles reinfesting the area would have to come from untreated trees outside its borders or trees that were missed in the control work within the area.

The area within the Forked Meadow Unit was designated as the intensive zone in which all infested trees were to be treated throughout the season as soon as they could be located by cruises repeated at intervals of about twenty days.

Around the borders of this unit a secondary zone one-half mile in width was established. No trees were to be treated within this secondary zone except trees that might occur along the boundary of the intensive zone.

After the infestation had been reduced to its lowest point, the probable distance of flight was to be determined by carefully locating and mapping

1. All trees within both the intensive and secondary zones from which new broods of beetles emerged;
2. All trees attacked within the intensive zone; the location of each tree to be determined with reference to the nearest infested tree from which beetles emerged just preceding the period of attack.

The method of this experiment would not in any way determine the direction from which beetles came to attack trees except by inference. The heaviest centers of infestation in the surrounding areas during 1923 and 1924 were located in the Jackass Unit, part of which was included in the secondary zone to the north and east of the Forked Meadow Unit. The areas to the south and west of the Forked Meadow Unit were covered by control work during the seasons of 1920 to 1923, and during 1923 these areas developed comparatively light infestation compared to the Jackass Unit. The possibility of the greater number of beetles coming from the northeast to reinfest the intensive zone would be expected, in view of these conditions.

RESULTS

The intensive control work in the spring of 1924 resulted in burning the barkbeetle broods in all but five of the 1923 overwintering trees in the intensive zone. These were trees that because of green foliage were not detected until after the beetles emerged. This represented an infestation of one tree per section, and all but one tree were located near the eastern boundary of the intensive zone. Beetles also emerged from eight 1923 overwintering trees in the secondary zone. This made 13 trees in and around the intensive zone to account for the beetles that entered the cleaned area to make the attack of the first seasonal generation of 1924.

The emergence from the 13 overwintering trees that were not treated occurred early in May. Following this emergence 15 new trees were attacked within the intensive zone by June 1.

Eight of these 15 trees were not treated, and the emergence of these broods, together with the emergence from 16 trees in the secondary zone, was followed by the attack during July upon 37 trees within the intensive zone. These 37 trees constituted the second seasonal generation of 1924.

Fourteen of the second seasonal generation trees were missed in the control work. The emergence from these missed trees, together with that from 22 trees in the secondary zone, was followed by the attack, during late August and September, upon 49 trees in the intensive zone. This attack constituted the third seasonal or overwintering generation of 1924.

Table I summarizes the number of untreated and attacked trees by generations:

TABLE I

<u>Generation</u>		<u>Number Trees in</u>		<u>Total</u>
		<u>Inten. Zone</u>	<u>Sec. Zone</u>	
1923 III (overwintering)	Untreated	5	8	13
1924 I	Tot. killed	15		
	Untreated	8	16	24
1924 II	Tot. killed	37		
	Untreated	14	22	36
1924 III	Tot. killed	49		

The total seasonal loss within the intensive zone represented by all three generations amounted to 101 trees, or about 20 trees per section. The total volume of this loss was 176,000 board feet, which was more than twice the amount of timber killed in 1923.

The movement of the infestation across the area from east to west, brought out by comparing the three maps, is especially significant. In Map I an advance of the infestation of about one-half mile into the north and east sides of the intensive area is shown. The remainder of the area is practically free from insect loss. Map II shows both a building-up of the infestation in the area invaded in the first generation and also another advance of a little over a half mile toward the west. This still leaves about half of the area practically free from infestation. Gen.III, as shown on Map III, finally spreads out across the entire area, evidently both by spreading east from trees left inside the intensive area and by working in from the secondary area on the west.

A noticeable point is the movement of the heavy centers of infestation from the east side of the area as shown in Map II, to the west side of the area as shown in Map III. The explanation for this probably lies in the tree-selection habits of the western pine beetle. The emergence from the Gen.I trees took most of the susceptible trees on the east side of the area, so that the emergence from the Gen.II trees had to go elsewhere to find trees favorable for attack. It also brings out the main difference between more primary beetles, such as the Black Hills beetle and the mountain pine beetle in lodgepole pine, and the western pine beetle. The Black Hills beetle, being less selective, is able to build up an infestation that will kill out the entire stand over a large area when conditions are favorable. This the western pine beetle is never able to do, because when the supply of susceptible, slow-growing trees is exhausted the epidemic is soon broken by the resistance of the more vigorous trees. This also explains why drought has more effect on a western pine beetle infestation than on a Black Hills beetle or mountain pine beetle infestation.

DISTANCE OF FLIGHT

There seems to be no method by which the distance actually traveled by the beetles in going from one tree to another can be determined under the conditions of this experiment. The beetles might have come from a tree much further away than the nearest point of emergence. However, unless our present ideas of the behavior of these beetles are entirely erroneous, they could not have traveled any distance shorter than that from the nearest tree where emergence occurred to the point of attack.

By drawing a line from each attacked tree to the nearest tree of the preceding generation where emergence occurred, we have the shortest possible distance that beetles would have to fly to make the attack. We cannot tell whether the beetles followed this line or not, and the chances are highly improbable that they did; but for all practical purposes the distances measured in this way represent the general advance of the infestation.

Table II represents the maximum, minimum and average distances for trees of each of the three seasonal generations. These measurements were made by plotting trees on a map drawn to the scale of 4 inches to the mile and measuring the distance to the nearest untreated tree of the preceding generation.

TABLE II

<u>Generation</u>	<u>No. Trees</u>	<u>Distance to nearest point of emergence</u>		
		<u>Maximum</u>	<u>Minimum</u>	<u>Average</u>
1924 I	15	1320 yds.	220 yds.	783 yds.
1924 II	37	1430 "	10 "	580 "
1924 III	49	1550 "	20 "	627 "

The greatest distance recorded by this method was 1550 yards or .88 of a mile, while the average distance ranged from 580 to 783 yards or from .33 to .44 of a mile. Thus the entire reinfestation of this unit during the 1924 season could be accounted for by flights not exceeding one mile and averaging less than half a mile.

POSSIBLE RELATION OF FLIGHT
TO INCREASE AND DECREASE OF INFESTATION

The season of 1924 was one of exceptional drought and a very marked increase of western pine beetle infestation occurred throughout much of the Sierra region. Apparently the beetles took advantage of a weakened condition of the trees, due to insufficient moisture, and succeeded in killing many that under normal conditions would have been resistant. This factor may have influenced the results of the flight experiment, due to the fact that the beetles did not have to fly far to find susceptible trees, but to what extent cannot be determined.

A comparison of the volume of timber killed by barkbeetles during the seasons of 1924, 1925 and 1926 on the Forked Meadow and Jackass Creek Units is shown in Chart 1. By comparing the loss of the two summer generations with the overwintering generation it will be noted that the infestation on the Forked Meadow Unit during 1924 increased much more rapidly than it did on the Jackass Unit. This increase occurred in spite of the fact that control work was carried on in Forked Meadow against the two summer generations and more than 50 per cent of the trees were treated, while in the Jackass Unit no control work at all was done. Aside from control work all other conditions on the two units were approximately similar. On the other hand, during the seasons of 1925 and 1926, when no control work was done, the infestation in Forked Meadow was proportionately much less than on the Jackass Unit.

This behavior of the infestation is not easily explained, but it can be accounted for by a drift of beetles from Jackass Creek to Forked Meadow during the season of 1924 and a return drift to the Jackass Unit during 1925 and 1926. This assumption would indicate that the general distance of flight was further than that determined by the averages given in Table III. However, no conclusive evidence has been secured as

to a general movement of beetles from one area to another, and much experimental work must still be done on this phase of the barkbeetle problem before conclusions are warranted as to the extent to which flight of beetles may affect the increase or decrease of beetles in any particular area.

APPLICATION OF RESULTS

The results of this study have a direct bearing upon the question of whether or not it pays to carry out control work on a small area of a few sections which is not isolated by type breaks or topographic barriers from adjoining areas of infested timber. Obviously under the conditions of this experiment the control work was a failure from a protection standpoint. However, these conditions were exceptional in that the control was carried out during a season of drought, when resistance of the trees was lowered.

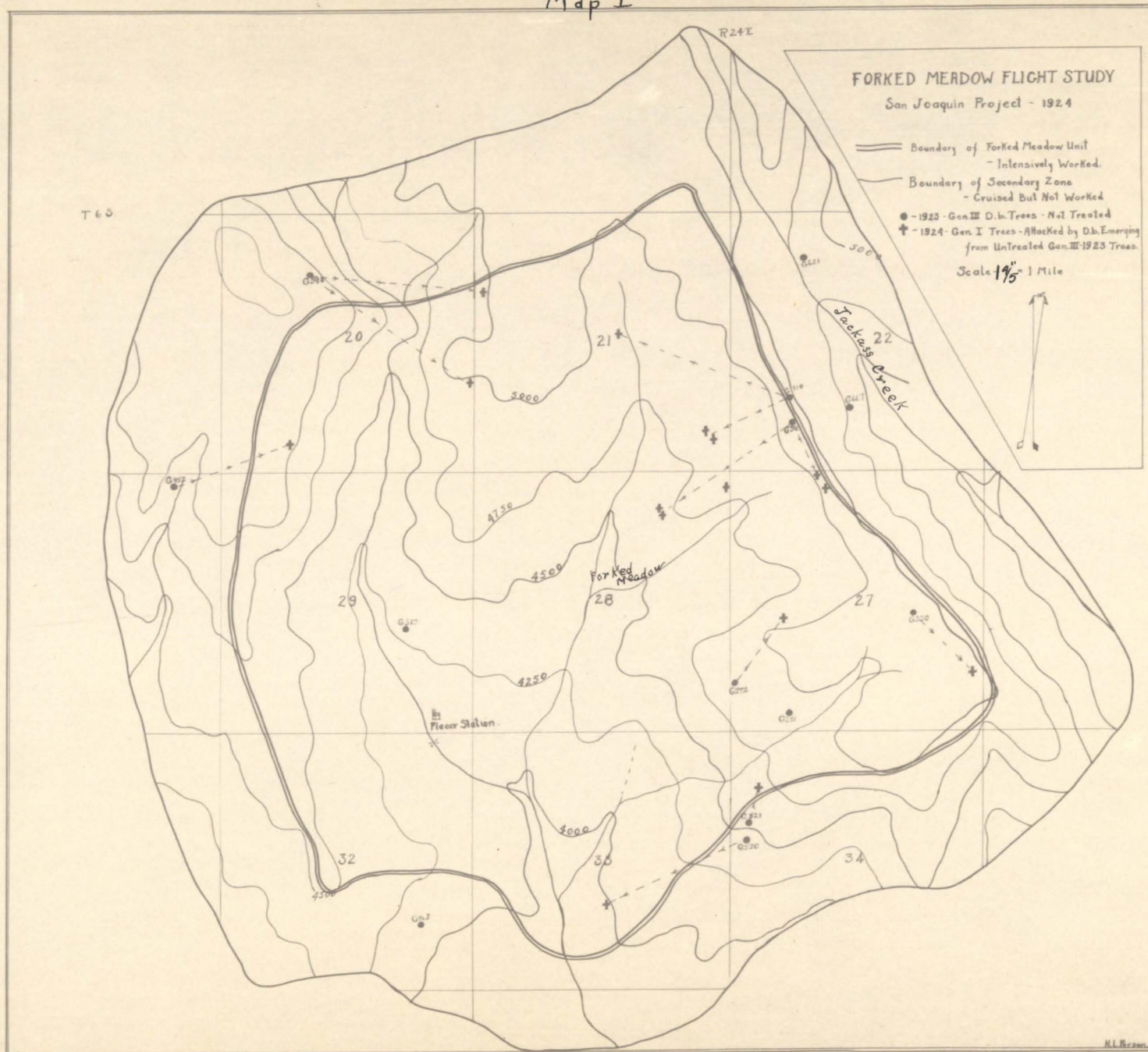
The fact that the control work was carried on against an endemic infestation should also be considered in this respect. An infestation of 20 trees per section, such as developed during 1924, would not be considered epidemic nor of sufficient importance to warrant control work under the standards now accepted in the protection of commercial stands of yellow pine against barkbeetles. Zeen, in his analysis of the Southern Oregon-Northern California Project, places an average annual loss of 60 trees per section as the point below which it does not pay to consider control work, as the reduction of losses that can be secured will not be sufficient to offset the cost of the work.

GENERAL SUMMARY

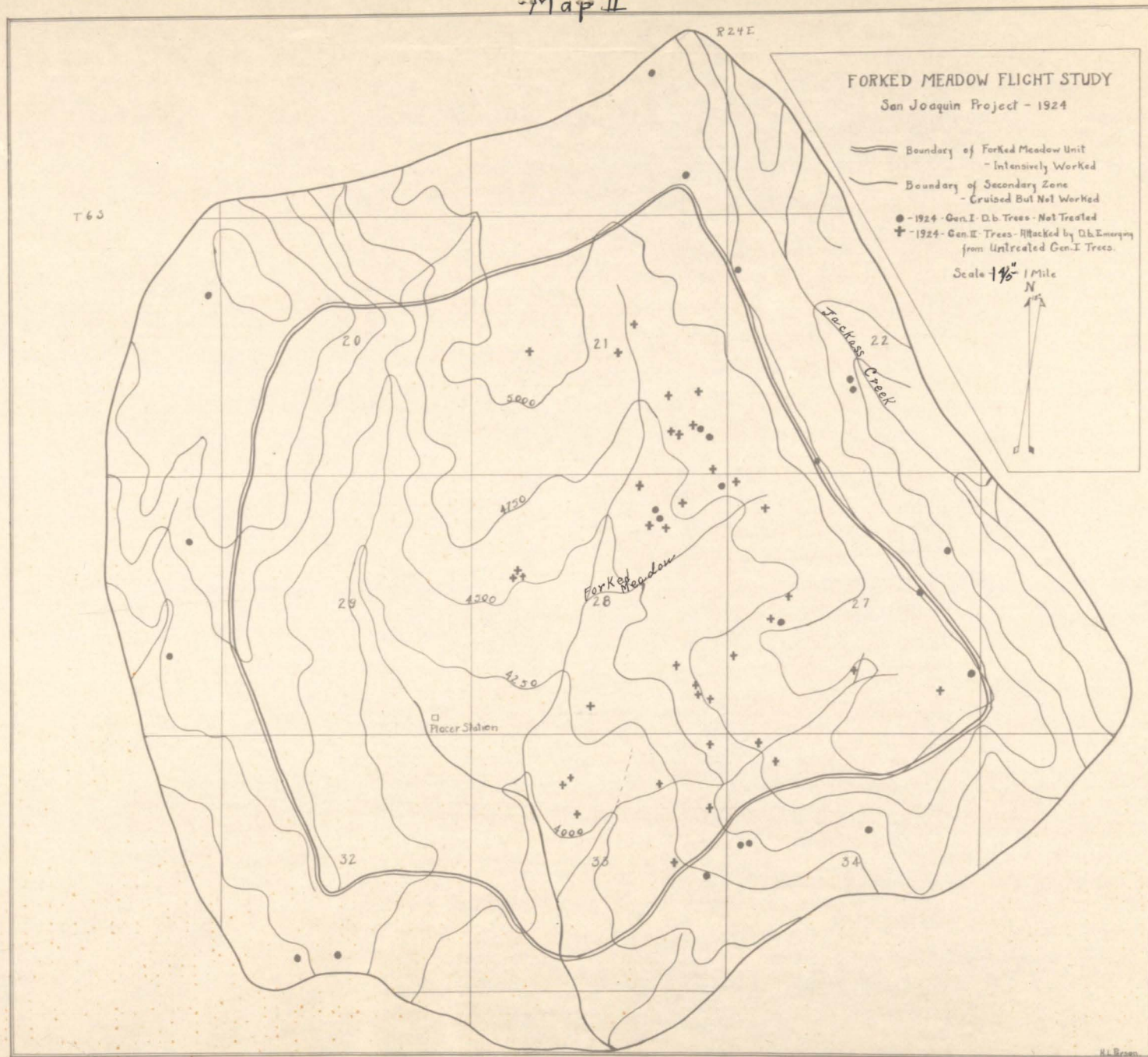
The outstanding results of this experiment are:

1. An area of 3200 acres, with a diameter ranging from 2½ to 3 miles was practically clear of western pine beetle infestation at the beginning of the 1924 season. The number of overwintering infested trees within the area from which beetles emerged to start the 1924 infestation was 5, or an average of 1 tree per section.
2. This area was completely reinfested during the course of the 1924 season, so that the seasonal loss in the unit was more than twice that of the preceding season of 1923. The total 1924 loss averaged 20 trees per section.
3. This building up of the infestation within the area during 1924 resulted in part from beetles coming in from surrounding zones. This assumption is supported by the fact that over half the trees in each of the summer generations were located and treated before the beetles emerged.
4. This entire reinfestation of the area can be accounted for by a flight of beetles not exceeding a mile in any one case. The average distance from trees attacked to the nearest tree from which the attacking beetles could have emerged was less than half a mile.
5. Control work on areas of a few sections immediately adjoining other infested areas does not appear to be practicable in view of the rapidity with which the worked area may become reinfested.

Map I



Map II



Map III

R 24 E

T 6 S

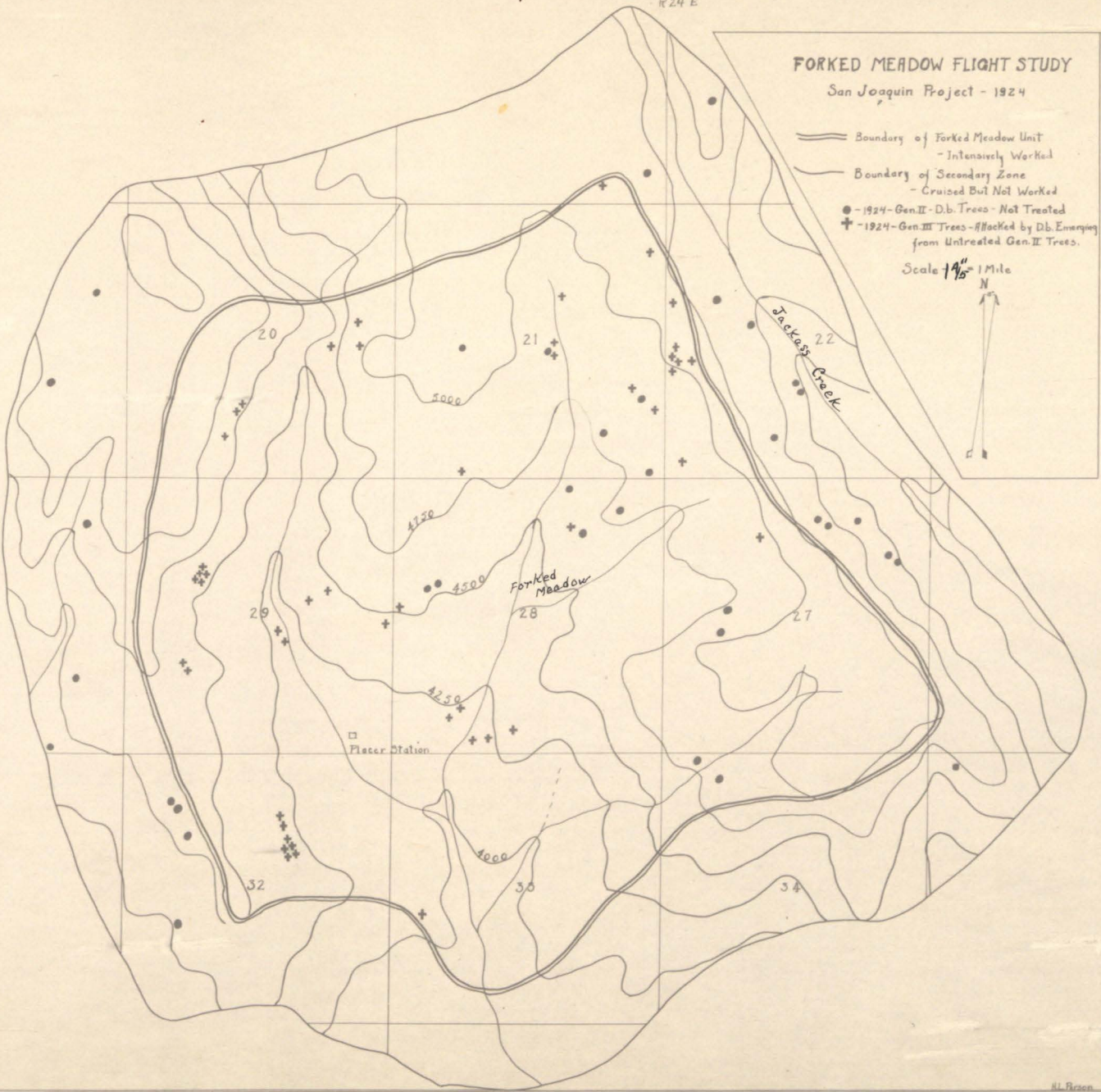
FORKED MEADOW FLIGHT STUDY

San Joaquin Project - 1924

- Boundary of Forked Meadow Unit
- Intensively Worked
- Boundary of Secondary Zone
- Cruised But Not Worked
- - 1924 - Gen. II - D.b. Trees - Not Treated
- + - 1924 - Gen. III Trees - Affected by D.b. Emerging from Untreated Gen. II Trees.

Scale 1 1/2" = 1 Mile

N



350 M.B.M.

300 M.B.M.

250 M.B.M.

200 M.B.M.

150 M.B.M.

100 M.B.M.

50 M.B.M.

Volume Killed Annually
by Western Pine Beetle
on Forked Meadow and
Jackass Creek Units

S = trees killed by
Summer generations

W = trees killed by
overwintering generation

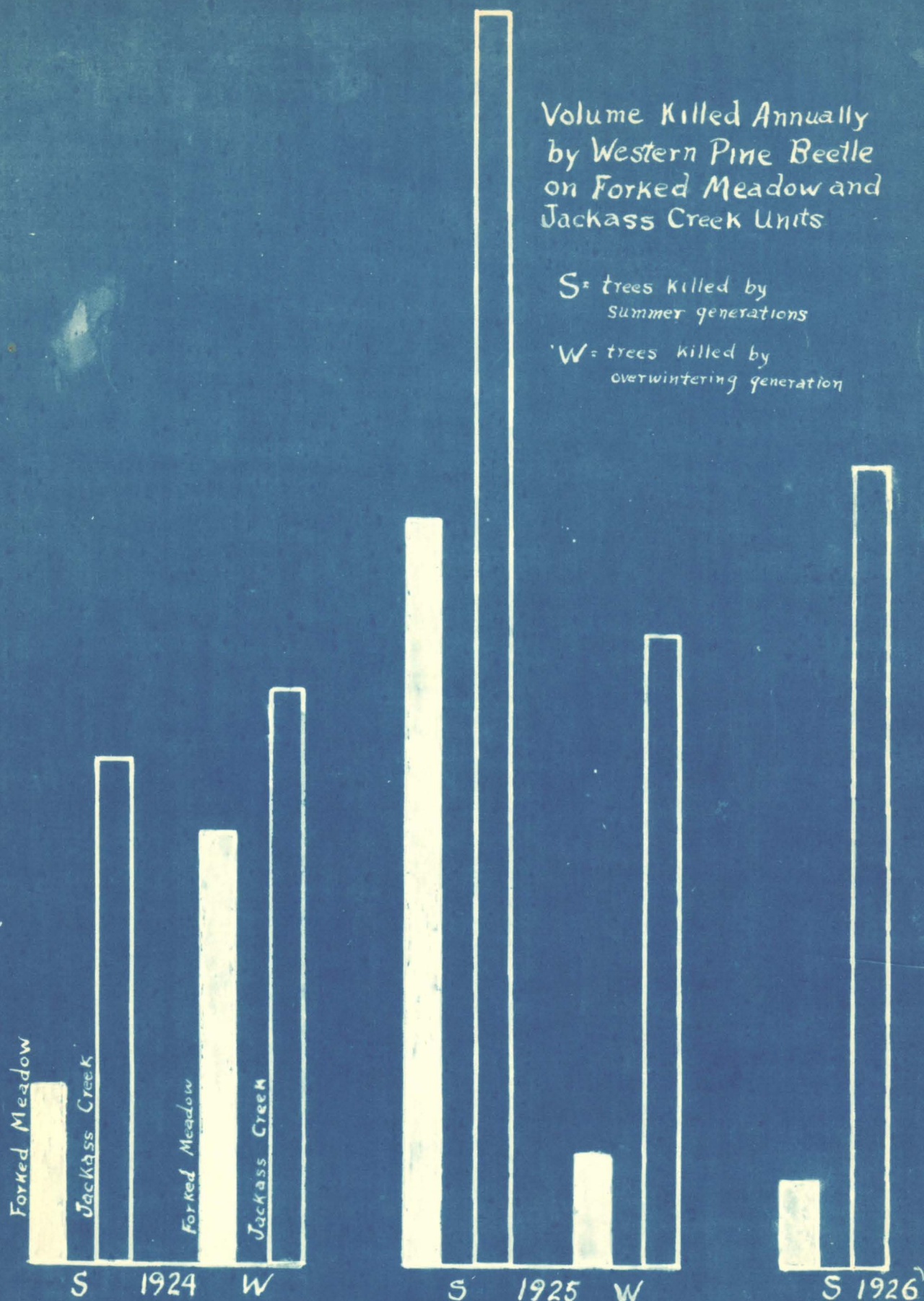


CHART I